ON THE

GEOLOGY OF MALTA AND GOZO.

BY

COMMANDER THOMAS A. B. SPRATT, R.N.

SECOND EDITION.

SOLD FOR THE BENEFIT OF THE LITERARY AND SCIENTIFIC SOCIETY OF MALTA.

1854.

Bradbury & Evans,] *Price Sixpence.* [Printers, Whitefriars.

VIEW OF THE DEPRESSED BASINS NEAR THE N.W. CAPE OF GOZO,

To illustrate the origin of the Maclouba Basin.

VIEW OF RABATTO AND 7 TABLE HILLS OF THE BEDS A.B.C.

From the denuded district near Casal Sukeca.

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This paper, on the Geology of the Islands of Malta and Gozo, was, by my request, given to me by the Author, Captain Spratt, R.N., with his permission to print it, and I do so in the hope that it may lead to a closer investigation of the structure of these Islands. Since the first edition was printed, a collection of specimens, illustrative of the Geology of Malta and Gozo, has been formed by the Librarian, Dr. Cesare Vassallo, and placed in the public library of Valletta.

WILLIAM REID,
Governor.

Palace, Valletta.
1*st Feb.* 1854.

Since this edition has been printed Captain Spratt has requested that the following note be added to it.

Note—"Through the recent researches of Professor Forbes the present President of the Geological Society of London—Malta with other contemporary deposits in the Mediterranean and France, are considered to be a part of a late Eocine period, and not Miocine as formerly supposed."

GEOLOGY OF MALTA AND GOZO.

CHAPTER I.

The Geology of the islands of Malta and Gozo is similar, and consists of a considerable portion of the middle division of the tertiary formation, viz.: the miocene.

The numerous fossils and fine specimens of sharks' teeth and echinodermata which the deposits of these islands contain, have long attracted the attention of the collector and the geologist visiting them. And amongst the former, some have been found nearly five inches in length; vestiges of a gigantic, but fortunately, extinct shark. Of the echinodermata, eight or nine genera have been identified by my friend, Professor Forbes, the eminent palœontologist; some of which contain three and four species.

In the collections made previously to the time I worked upon the geology of these islands, fossils of a much older time were generally to be found, such as belemnites and others: so that Malta was from this cause, considered to contain some relics of the secondary formation. The numerous echinodermata too, leant to this opinion, which was then known, only as a more common condition of that age, than of any other. It however soon became evident that these secondary fossils had no connection with Malta or Gozo, but that they were in fact, purchased by the vendors of fossils in Valletta, from sailors, or were sent by their connections from other localities, yet sold to the ready purchasers *as true Malta fossils!* So that I have known Syrian fish, and fossil trees from Egypt sold in the island as Maltese. I therefore give this caution to the future purchasers and collectors of fossils, that they may be on their guard against such tricks; and more particularly advise the native geologist or student to buy none, but to spare no pains to collect his own—so as hereafter to give a more satisfactory account of the geology of his native island than I have here attempted; or at any rate, to understand it better than my researches and descriptions will enable him to do.

Having thus stated what age Malta was for some time considered to be, and what it really appears to be, the local student will thus start on his research, hammer in hand, with a clear understanding that whatever fossil his hammer and zeal procures him, no matter how diversified the strata from whence it came, whether sandstone, marl, or limestone, that he is working upon what is now considered to be of a purely miocene

age—that is, the middle of Sir Charles Lyell's third division of the tertiary series—and although limited as this simple division is, in comparison to the whole geological era, yet it affords a field of much interest from the peculiarity of its strata, and the very fine state of preservation of some of the fossils which are embedded in them.

There must be, however, both time and labour bestowed to procure them, but which will be amply repaid in several ways to the diligent student. First by the enjoyment of a healthy recreation amongst some romantic spots which the islands possess, and chiefly amidst some very beautiful specimens of cliff and coast scenery; secondly, he will experience the gratification of knowing the genuineness of every fossil in his collection, when procured by his own hand and hammer, instead of by the insipid means of exchanging a few pounds or pence for them, with a local dealer; from whom no sort of information can be derived, as to their *superposition*, or the particular *stratum*, from whence any of them came.

And this order of superposition, as well as the nature of the formation in which fossils are found, should be particularly attended to by the young geologist. For the inhabitants of those fossils, were in most cases, inhabitants of certain regions of depth. So that the fossils of the lower series of deposit, as the sea bottom rose in height by its accumulations, were mostly replaced by others in the upper series; consequent mainly upon the increased temperature by a nearer approach to the surface, thus producing a new climate, and thus requiring animals and an organisation specially adapted to it, and so on to the last or uppermost. That is, if no uprising or subsiding of the sea bottom by volcanic action, hastened the change, by changing the conditions.

A knowledge too of this distribution of the fossils in a formation, where some of the deposits in the series bear a close resemblance in mineral character, as in Malta, is very necessary to the working geologist, since they at once enable him to identify the relative height or depth in the series to which any detached bed in which they may be found belong. But this requires a patient investigation at some favourable locality. I shall therefore direct the student to the best for this purpose; viz., the Bays of Marsa el Forno, Ramala, and cliffs under Fort Chambray in Gozo, and all the whole range of western cliffs between Melleha and Dingli or Emtaklep, in Malta, particularly at the hills above the point E in the accompanying map.

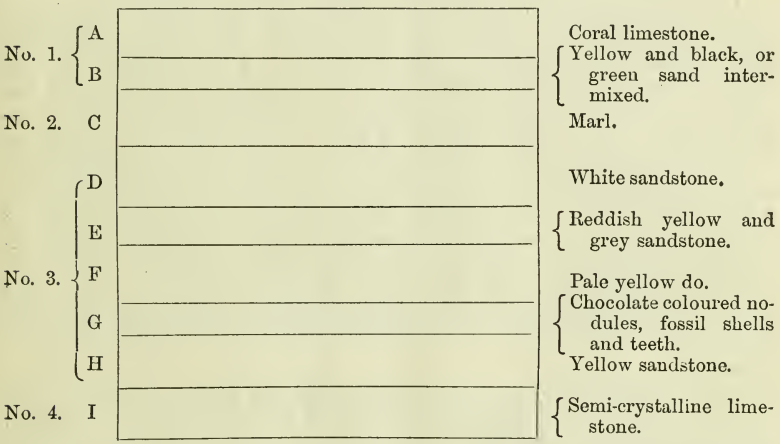
Malta is in length seventeen miles, and in breadth seven miles. Whilst Gozo is little more than nine miles long and five broad. Their direction is SE. and NW. and the length of the axis of the chain, which includes the intermediate islet and channel of Cumino, is 29 miles.

The mineral deposits composing this group, which comprises a thickness of about 800 feet, visible above the sea, lie nearly horizontal, and are comformable, although there is a great diversity of mineral character and condition in the series. None of the deposits are wholly destitute of organic remains, but, on the contrary, they generally contain them in tolerable abundance, and in a good state of preservation. The number of organic remains, shells, &c., found in one or two of these deposits, indicate that at the time they were being formed, there existed a sea bed, most prolific of animal life; and the great quantity of fish

teeth (principally of the shark tribe found in one or two beds of the series) intermixed with these fossils, show that at that particular time of the series, the sea abounded with these voracious creatures: of which nearly all the species are now extinct.

CHAPTER II.

The different strata, for distinction and convenience, I divide into four groups, shown in the following section, which is however arbitrary, since they pass gradually into each other.



The above groups are distinguishable both by their mineral characters, and by their fossils, some few of them only being common throughout.

1st. The upper crust is designated the coral limestone, from its generally containing masses of corals embedded in it, as well as shells.

2nd. Is a remarkable bed of gray and blue marl.

3rd. Beds of white and calcareous sandstones often thinly stratified, and always of fine grain.

4th. Compact and semi-crystalline limestone interstratified with coralline grit and indurated sandstone, generally white or cream coloured.

The first group A, in the section distinguished by me as the "coral limestone," consists of a reddish white calcareous rock, mostly compact and hard, but sometimes changed into a yellow sandstone.

Its original thickness exceeded 100 feet: being full that at some of the localities in the north part of Malta hereafter to be described, where it seems to have been protected by being submerged (see section No. 1 and No. 5 at St. Paul's Bay) whilst the upper summits of the Island were undergoing denudation or atmospheric degradation.

In Gozo some of the hills have a capping of this deposit, of from 20

to 30 feet: whilst in one hill near Casal Garbo, it is entirely gone, the hill being formed of the subjacent marl only. And in another spot towards the NW. cape of Gozo, some remnants of this upper crust now lie on the deposit No. 3, below the marl: that intermediate soft deposit having been entirely washed away, and thus, by the accidental compactness and hardness of the limestone here, some fragments have endured the denuding action that removed at least 100 feet of the deposits formerly subjacent to it—and this limestone from being not only hard, but a little variegated in colour, was formerly used for certain durable work, and known as the "Gozo marble."

B. Is a stratum of soft yellowish red sandstone or loose sand; of a variable thickness, from eight or ten, to nearly twenty feet—and is distinguished by having a large quantity of greenish black grains intermixed with the yellow sand. It abounds in organic remains, most of which differ from those of the deposit A above it.

A very characteristic fossil of this bed, is a small, thin, chambered shell, like a miniature nautilus or nummulite. It is the *Lenticulites complanatus:* a *Foraminifera,* which occurs in some localities in vast quantities; as in the cliffs of Ramala Bay, Gozo, where this deposit has assumed its maximum thickness of nearly twenty feet by the accumulation of their relics. They usually lie with their flat sides parallel to the plane of stratification, so that it is clear they were not swept here in a heap by the effects of some sudden currents; but evidently swarmed in a living state at the locality, when it formed part of the sea bottom; owing no doubt to some more favourable condition for their reproduction and growth, than at the other parts of this deposit. Associated with this nummulitic shell are layers of oysters; and the teeth and vertebræ of fish are frequently found also, chiefly of the shark tribe, but sometimes good specimens of teeth and vertebræ of cetacea are also obtained.

I can recommend the NW. coast of Malta and the eastern and southern cliffs of Gozo as the best localities for examining this deposit; perfect casts of univalve and bivalve shells are also found in it, which are generally of a dark chocolate colour, and indurated, so as to resemble, by their superficial lustre and fracture, a dark porcelain.

Thus we have a representation of a frequent condition of the sea bottom at the present day, viz., that where an abundance of any one kind of animal life exists, we have its attendants of other species, for prey, protection, or through the adaptation, in common, of the food growing there.

Second Group. C. Is a thick bed of marl, or clay of a dark blue or light gray; and even in some localities approaches a light brown, when it is less plastic and marly, and therefore not always recognisable to the eye. It is not stratified, although it has horizontal bands of colour. The marl contains crystals of gypsum, and occasionally nodules of sulphur also; which once induced a Sicilian speculator to dig for this article in the marl beds of Gozo; where the deposit is better developed, and the nodules of sulphur more abundant than in Malta; thus hoping to find a greater quantity at a greater depth, because a few nodules were visible at the surface. But his efforts were fruitless, as any geologist, after inspecting the formation, could have told him.

The marl contains a few organic remains (see list), all of which have

served as nuclei to irregular nodules of iron pyrites; so that the fossils themselves often require an experienced eye to distinguish them as being really the relics of organic life. In this bed, occurs the bone of a small species of sepia, and a nautilus, viz. the nautilus zigzag, is also found, which latter is of interest as having been previously known only in the eocene beds of the Paris and London basins; and therefore till found here by me, was considered an exclusively eocene fossil.

Third Group. D. Is a white calcareous sandstone lying immediately subjacent to the marl, into which it quickly passes, and is from twenty to thirty feet in thickness.

E. Is a bed of fine grained sandstone, fifteen to twenty feet thick, of a reddish white, and sometimes gray colour. These two deposits contain several species of *Foraminifera*, a microscopic shell often resembling seed-vessels.

F. This deposit, of from thirty to fifty feet in thickness, and of a pale yellow calcareous sandstone, which often contains nodules of a flinty texture, viz., chert, in which are fish-scales. It varies much in quality; is in some parts thinly stratified, and separable into brittle plates of sandstone; but more generally it assumes a closely bound, and unstratified character, although soft, and is sometimes used for building; but it is very liable to exfoliate on exposure to the weather. It contains a fine scalaria, and other fossils.

G. A bed, varying from two to eight feet thick, of calcareous sandstone, is remarkable from being either in great part composed of, and always containing irregular nodules; with which are mixed casts of shells, and other organic remains; caryophylla, &c. (see Forbes' Catalogue), these masses seem all due to organic origin. In this stratum also fish teeth and vertebræ are particularly abundant.

In fact it is from this bed that collectors chiefly procure them; and the deposit preserves its character throughout the islands. But in Gozo it is better developed, and more abundant in organic remains. Particularly at a flat ledge just above the sea under the cliffs of Fort Chambray; and also at Marsa el Forno on the N.E. coast of that island, where its durability and hardness seem to have checked the encroachment of the sea. All the nodules in this bed seem, in some way, due to organic origin, either coprolitic or otherwise.* As a guide to the local student, I must point out that he will find this deposit on the coast near Marsa Scala. Also a remnant is visible on the top of the Eslima ridge; and under Fort Tigni, also near the foot of Città Vecchia hill, in a field on the right hand as he ascends by the road, he will see a band of it on the face of a small sandstone cliff, which from the road looks like a bed of gravel.† On meeting this deposit at any other locality, he will then be able to identify the exact position in the series of the strata in immediate contact with it. This will show him how much has

* This bed deserves attention, for if these nodules are really due to organic matter, they could be made very valuable as manure or dressing to certain soils by crushing, a plan now recently adopted in the south-east district of England.

† This fossiliferous band is, however, best developed and studied on the west escarp of the Benjemma range; particularly over the west extremity of the great transverse fault which divides this island. This band can be here examined for a considerable distance round several projections of the ridge, and appearing there as a horizontal zone or belt encircling them.

been denuded from above it, and also lead to other interesting points connected with its local elevation above the sea, and its continuity, &c.; for it was continuous through the two islands; and therefore when found, is a certain indication of the group to which its associated beds belong.

H. Is the lowest portion of the soft sandstones constituting the third group of deposits, and attains a thickness of from forty to fifty feet. All weather-worn cliffs of this deposit show distinctly a stratification, although not a separable one—but when cut down smoothly by an instrument, the evidences of stratification are obliterated, as may be seen in the numerous quarries of Casal Luca, where it is extensively worked for building and other purposes. This stone is capable of being cut with great facility by the hatchet; or formed by the lathe into pillars, vases, and balustrades, and other architectural ornaments; and is in consequence used extensively in all public and private edifices; besides being an article of considerable export to many parts of the Mediterranean, as flag stones, &c. A fossil turtle was once found at one of these quarries; also crustacea, with portions of the vertebræ and tail of a fish. A few echini and a pecten are its chief fossils. The stone from which the finely carved vases are produced is also from the lower part of this group, which is chiefly obtained near Naxiar; as the stone there found dries whiter, is finer grained, and more compact than in general.

Fourth Group. I. The lowest of the four deposits of the Maltese Islands is a yellowish white, and cream-coloured limestone, of a variable quality, having sometimes semi-crystalline and compact strata alternating with an oolitic grit or coarse sandstone apparently composed of minute fragments of coral and shells.* This group attains a considerable thickness; since nearly 400 feet of it in perpendicular depth is visible on the NW. coast of Gozo. The more compact and durable strata of this group are highly valuable for building, and it is quarried in three or four localities for this purpose, viz., St. George's Bay, &c. The new dock was in great part formed of some of its semi-crystalline limestones, so hard and durable is it found to be. The fossils it contains are very difficult to be obtained perfect on this account; and therefore has had but a partial examination by me. Yet two or three species of echinodermata, peculiar to the lowest group, are not difficult to be got in some localities, such as a scutella, and they very often occur in bands or beds, parallel with the line of stratification, also a very large species of conus. Fragments of minute crustacea, have likewise been seen by me in this deposit; but its characteristic fossils are the scutella, as well as numerous linear and curving bodies, that seem to be the refilled borings of some annelide; or the casts of the leathery tubes of an amphitrite—similar perhaps to those so common in these seas at the present day. There are also cylindrical tubes, that seem to belong to a mollusc, and not an annelide.

* Some of the strata of this group cannot be distinguished from the upper coralline limestone. And at the point of transition from the third group of sandstones into the fourth group of compact limestone, the *Lenticulites complanatus* of that upper group, with a small terebratula and other fossils, were recently discovered by the present Earl of Ducie during his close research of the geology of Malta.

The enterprising and native geologist and naturalist, who has more time and opportunities at his disposal than I have, will soon discover that there are many points of interest to solve connected with a proper knowledge of the geology of these islands, and the relics of organic life within it, although limited as the formation is in geological time and in variety of material.

CHAPTER III.

DESCRIPTION OF FEATURES AND DISTRIBUTION OF THE DEPOSITS.

The two islands of Malta and Gozo attain nearly the same height, viz., about 700 feet; Malta exceeding the highest point of Gozo by some few feet. In the latter island, the two upper groups of deposits are better preserved, and more generally distributed over it than Malta, and the island is so intersected by valleys, as to divide this upper series of deposits into eight or nine isolated hills, each with flat summits and very steep sides; owing to the capping (A) still remaining, as the former cause: and to the rapid waste of the subjacent marly bed, as the other. These several hills thus give a more picturesque character to this island than Malta presents, and their abrupt sides better develope the formation. (See View).

Malta on the contrary, and particularly in its south-eastern half, presents a rather monotonous uniformity of geological features: the island being in that division, chiefly denuded down to the middle of the third group of deposits. Thus presenting only extensive undulations on elevated slopes, but intersected by two or three rocky valleys.

This denuded district extends from Valletta to the foot of Città Vecchia, and from Naxiar to Marsa Scirocco. But at the western extremity of this elevated flat a change of feature takes place by the rising up of the land into what are called the Benjemma hills: these hills are formed of the superior beds 1, 2, and 3, complete, which without doubt formerly covered the whole tract, also between them and Valletta, being here the remnant which escaped the denudation that has carried off the corresponding strata from the whole of that portion of the island. This will be at once understood by reference to

Section 1.

which is a longitudinal section of the chain formed by Malta, Cumino, and Gozo, by which it will be seen that a large intermediate portion of this chain has a considerable depression below its two extremes. This very interesting displacement of the strata is pointed out by two great faults that extend across the two islands perpendicular to the axis of the chain. The Malta fault divides the island into nearly two equal parts; and is well shown in the very interesting and instructive Section, No 4, which is merely a general sketch of a sea cliff, at the western end of the Gianhina valley, immediately at the NW. base of the Benjemma hills. The fault from this point follows the line of the valley, under the north

escarp of the Benjemma, Musta, and Naxiar ridge; and meets the sea on the opposite coast at the Bay of Maddalena. Those rocky precipices and escarped ridge which overlook the Naxiar plain, are in fact the upraised side of the fault; and consist of the indurated strata that belong to groups 3 and 4, but more particularly the latter. This the diligent student will soon detect, by the contained fossils; and although the rocks on the opposite sides of the fault appear the same, the fossils from either side will be found different, the groups 1 and 4 being in contact. It was by the want of conformity or correspondence in the fossils found in the two series of deposits, to the north and south of this fault, that led me after some long examination, to suspect the existence of such a displacement. And by following out the suspected course I fell upon the confirming evidences of it, at the Gianhina cliff, shown in Section 4, which is well worth a visit by every student interested in the remarkable features of his native island, or interested in its geology, and desirous of enriching his collection, for few localities are better for this purpose than the vicinity of this fault. A calesse road leads to a farm-house within a quarter of a mile of it, and the distance does not exceed twelve miles. Whether for the geological interest, or for the beauty of the coast scenery, or a mere pic-nic excursion, I can equally recommend the visit to him and strangers.

Following up the examination of this depressed strata to the north of the fault, I found that it terminated at another fault parallel to the former, at the south end of Gozo; viz., from the gorge of Ain Selim, towards the bay of Scilech (see Map and Section 1). The down-coast here being also nearly equal in amount to that at the Gianhina cliff, viz., about 400 feet. Thus defining the limits of the district so depressed, which includes the straits of Freeghi or Cumino; the latter island being also a portion of the part let down, since it is composed wholly of the coralline limestone.

Besides these two faults, there are several minor ones upraising or depressing some small portion of the island. The principal of which is on the north side of St. Paul's Bay (see Map and Section 5), where a fault of two miles in length, lets down for a depth of at least 100 feet, all the deposits lying south of it: so that the lower part of the bed (A) is in immediate contact with the bed (E) on the north side of the fault. This fault divides Salmonia island, and passes to the westward through the Salmoni ridge, a short distance to the south of Salmoni tower.

These numerous displacements indicate great volcanic disturbances, during the uprising of the island at various times. And they also indicate such a disconnection from the contemporary deposits existing in Sicily or the continents adjacent, as in my opinion to discourage any attempt at the procuring of water on the Artesian principle.

Section No. 3 is a transverse section of Malta, passing through Benjemma, Città Vecchia, Floriana, St. Angelo, and Ricasoli. It shows the extent of the district from whence the upper beds have disappeared, as well as the inclination of the deposits on that line. The dip of the strata to the south of the great fault is generally East, or ENE., at a very small angle, but sufficient to submerge, on the east coast, the chief portion of group No. 4, which on the west is elevated full 200 feet above the sea. No. 4 is thus almost wholly submerged between St. George's bay and Marsascirocco; whilst round to the west from Marsascirocco,

or Cape Benhisa, it attains a considerable elevation above the sea, as far as the fault of Gianhina; and from the hard and durable quality of this limestone, the shore presents a continuous unindented coast; being in fact one continuous cliff, or precipice.

That part of Malta which lies to the north of the great fault, presents a field of much interest to the geological student, from the three upper groups being there better developed, and more abundant in fossils than at any other. This district is divided into several hills and valleys, the cliffs surrounding which all deserve his attention and examination. He will perceive by Section No. 1, that in consequence of the great amount this intermediate portion has been let down, part of group No. 4 and but a small portion of No. 3 only appear above the sea level. And it is doubtless owing to the softer series of deposits being thus at this level, that its coast is so indented with bays and inlets. For the encroachment of the sea is evident and considerable in many parts of it: effected by the wash of the surf alone in the soft and shallow localities, but aided by the pholas and other boring shells on the deeper coasts.

It will be seen by reference to Section No. 1, that the soft deposits in the down-coast portion of the island are undulated, as if they had been subject to a considerable lateral pressure. So that the St. Paul's and Melleha Valleys appear to owe their origin somewhat to this undulation, together with the former degradation of its sides when the sea was at higher levels and these valleys were channels between them; thus again, in time, Melleha Valley will become a strait, separating the peninsula of Marfa from the ridge of Melleha, for the sea is encroaching rapidly on its western cliff, and the isthmus or valley is low throughout.

It cannot fail to be observed, on looking at the Sections or examining the district, that the thickness of the upper bed, A, is very considerable in the depressed or down-coast portion of the island; being often 100 feet thick: whilst in the more elevated positions occupied by this limestone, it is sometimes thinned out to a few feet. The thickness of this bed A, is here evidently due to its having been wholly, or in a great part submerged beneath the sea, during the long period that the sea was at the level of, and effecting the great denudation over, the extensive flat lying to the E. and SE. of Città Vecchia. Many changes of level by the uprising of the island, have taken place since this long period of rest, and the time of the great displacement between the two faults. But of its long continuance at this one particular level or elevation, viz. that of between 200 and 300 feet below its present, we have very certain evidences in the extent of the denuded districts both of Malta and Gozo; for there is a large portion of this latter island, also at its southern extremity, and about the same height of 300 feet above the sea, which has been similarly swept or denuded of its superior group, of strata—viz. from near Rabato to Chambray.

There are many other evidences of the former levels occupied by the sea, or rather by the island itself, in the numerous natural terraces which distinguish some of the hill sides; as also in the precipitous faces of some of the gorges or ravines: where, the rock being hard, the undermining effect of the sea at these levels is still preserved. These marks must not, however, be confounded with weatherworn surfaces or underminings where the stratum happens to be softer. In the gorge of Siggieui there are three or four such indications There are also two fine gorges in Gozo, viz. Highin Selim, and Scilendi, both well deserving

a visit by the geological student interested in the picturesque features of his native island.

Some other objects require a brief notice, such as the crevices or caverns that have been filled with calcspar, or stalagmitic productions. They occur in many parts of the island on a small scale, and I need only direct the student to the cliffs of Eslima, where he will find three or four such, filled with alabaster or calcspar of a dark brown colour, but variegated with lighter stripes of yellow and white, and commonly known as the Eslima marble. The origin of these calcspars will engage the student's attention and enquiry.—I believe them to have mostly resulted from the enlargement of rents in the rock by the sea, when within its reach. But by subsequent elevations fresh water alone percolating through the sides of the enlarged cavities, which have absorbed a quantity of calcareous matter during the passage, this was deposited in crystals as we now see it, and as the pure water evaporated slowly.

Maklouba must not pass unnoticed, being one of the most interesting natural features in the island, upon visiting which the general enquiry or question is, "How could it have been formed?" The explanation will follow its description, which is, a deep hollow in the vicinity of Krendy, and entirely surrounded by perpendicular cliffs of about 100 feet in height. Its diameter is from 200 to 300 feet, and the bottom is a fertile garden of fruit trees, accessible only by a flight of steps.

The district in which it occurs being a part of the denuded flat, this sunken hollow occurs in the fourth group of strata.

The explanation of Maklouba is shown in Gozo, where there is another somewhat similar hollow near the Dueira, or Fungus Rock, and existing in the corresponding group of deposits. But in the latter there is very certain evidence of the hollow being due to a local down-cast, or sinking in of the superior deposits—since they are now to be seen within this latter hollow; some portions of the marl, C, being thus in immediate contact with the beds of the fourth group. The following is an interesting sketch of the Dueira hollow from the sea (See plate No. 3), and must set at rest all ideas of its volcanic or artificial origin.

Most of the valleys in these islands follow the direction of the dip of the strata. The exceptions are the gorges of Siggieui in Malta, and of Highin Selim and Scilendi in Gozo. These appear to be due to natural but expanded or worn rents in the rock.

CHAPTER IV.

CONCLUDING REMARKS.

The Benjemma hills are noted for containing two or three fertile valleys, viz: that of Boschetto and Imtaklep. This fertility arises from the presence of the soft marl, producing a good soil; and also from the porous sandstone overlying it, retaining a great portion of the rain which falls on the surface of these hills.

The district in consequence contains several fertilising springs that

trickle from the sides of the valleys at the outcrop of the porous sandstone or marl. No spring in fact occurs in any part of the islands, unless there exists at that locality some of the deposits A, B, and C. This explains why Gozo and the North and depressed part of Malta, possess several such springs, which are of great value for local irrigation: whilst, on the contrary, the districts denuded of these deposits have no fresh-water springs: and any attempt to procure water in them, by making wells, Artesian or common, would in all probability be a fruitless waste of time and money.

The Benjemma range by having the porous sandstone, thus acts as a great sponge for the maintaining a continuous supply of water. Most fortunate it is, therefore, that this sponge has been preserved at the most elevated portion of the island,—for otherwise it would be useless as a reservoir for the supply of so necessary an article to your remarkable harbours and populous cities surrounding them. It is nature's cistern or reservoir for such a requirement. And in so viewing it, one cannot but perceive design and foresight on the part of the great hand that so retained this important fragment there. It is the natural and proper conclusion in contemplating this useful feature in the geology of Malta, as such views should be in the investigation of all God's works, great or small. And geology, which in its investigations, displays such vast movements and changes of feature and form in every continent and island during its preparation for man, is a science which especially awakens such views.

What would be the condition of these islands if there existed no such means for the supply of water to your populous city and its numerous shipping ? will be a question that must arise in the mind of the contemplative student. Could Malta have reached its present importance and prosperity, if thus deprived of so great a necessary to complete such a remarkable work of nature as these harbours present ? I thus merely open the idea, and leave the student to follow his own reasonings. But it seems to me a striking evidence of design and foresight. For the destroying agent was stayed just in time to preserve this small fragment of a former condition of the whole island, at the very spot where it could be of most service to a future and foreknown need, leaving man merely to adapt, by the exercise of his intellect, what Providence had thus preserved for his requirement.

This, too, amidst many and various disturbances which have occurred: that to an unthinking mind might all be attributed to accidental volcanic results. But in nature's operations there are few accidents—design, goodness, and wisdom are stamped on them all.

I may add also, that it is mainly through those displacements and dislocations by which the island has been shattered, that the remarkable creeks and canals forming the harbours of Malta have been produced: and which seem the more closely we study them to be more the work of studied art, than what is commonly conceived to be a fortuitous result of nature arising from such causes.

And with this geological fact before us, one is naturally struck with the conviction that design must have controlled those movements, thus to produce so many conveniences, and so many sources of employment arising from them, so to meet the wants of a prolific people, intended by Providence to be placed upon this little rock in the sea.

"NOTE on the Fossils found by Lieut. Spratt in the several beds of the Tertiary Formation of Malta and Gozo." By Prof. E. Forbes, Curator Geol. Soc. of London.*

Bed A. *Spondylus quinquecostatus*, Deshayes, identical with the Greek species. *Ostrea Boblayei*, Desh., *Ostrea Virleti*, Desh., a variety. *Pecten Pandora*, Desh., *P. squamulosus*, Desh., *P. burdigalensis*, and *P. Beaudanti? Clavagella?*

Casts of *Cytherea?* and *Arca*.

Terebratula ampulla, and *T. bipartita*, Brocchi. *Orthis detruncata* (*Terebratula*, sp.) Gmelin, identical with the existing species.

Echinus, sp. *Cidaris*, sp. *Nucleolites*, sp. *Brissus*, 2 sp. and *Spatangus*, sp.

Eschara monilifera. *Escharina*, sp.

Nullipora.

Remains of *Crustacea*.

Bed B. *Ostrea Virleti*, *O. navicularis*, Desh.? and another species. *Pecten cristatus*, Bronn? *P. squamulosus*, *P. burdigalensis*, and two other species.

Casts of *Thracia? Isocardia? Arca*, *Venus*, two species, and *Tellina*.

Scalaria retusa, Brocchi.

Casts of *Cypræa*, *Conus*, two species, *Oliva*, *Natica*, *Turritella*, *Turbo? Pleurotoma*, *Pyrula*, *Phorus*, and *Trochus*.

Clypeaster altus and *marginatus; Brissus*, three species.

Lenticulites complanatus.

Cellepora mamillata, *Myriapoda*, sp. *Retepora*, sp.

Cetacean remains (according to Prof. Owen, of more than one species of *Delphinus*, and the bones apparently of a *Manatee*.)

Fish-teeth (determined by Sir Philip Grey Egerton), *Corax aduncus*, *Carcharias mègalodon*, and *C. productus*, *Oxyrhina xiphodon*, *O. hastilis? O. Mantelli? Hemipristis serra*, and *H. paucidens*, with other *Squalidæ*.

Bed C. *Sepia*, sp. *Nautilus zigzag*, identical with the London clay fossil.

Scalaria, sp. *Pleurotoma*, sp.

Cast of *Mitra*, *Rostellaria* and *Columbella*.

Pecten burdingalensis, *Ostrea* sp.

Cardita, *Lucina*.

Spatangus, sp.

Caryophillia, sp. *Cellepora mamilla*, *Fungia?*

Bed D. *Vaginula depressa*, Daudin.

Cristellaria, sp. *Nodosaria*, sp.

Fossils common to Beds C. D. E. F. G.

Ostrea navicularis, *Pecten cristatus*. Casts of *Conus*, *Natica*, and *Cypræa*, *Spatangus*, and two species of *Brissus*.

Bed F. Two species of *Brissus*, and a *Nucleolite*.

Beds G. and H. *Pecten burdigalensis*, *Scalaria*, sp.

Scutella subrotunda, *Spatangus*, sp., and two species of *Brissus*.

* The chief matter in the preceding Memoir as well as the following Note on the fossils of Malta by Professor E. Forbes, were published in the "Proceedings of the Geological Society of London."

Bed H. *Nautilus*, sp.
Beds H. and I. *Pecten.*
Casts of *Lucina, Solarium, Conus, Phorus, Natica, and Cypræa.*
Balanus (*Lepas*, sp.) *stellaris*, Brocchi?
Scutella subrotunda, Clypeastar, sp. Two species of *Brissus Nucleolites, Cidaris.*
Mem. The species of *Brissus* found in the lowest beds are identical with those found in Bed B. Such is also the case with the *Pectens.*

"Report on the collections of Tertiary Fossils from Malta and Gozo." Presented by Lieut. Spratt, Dr. J. W. Collings, M.D., and Miss Attersol. (Read March 20, 1844.) By the Curator.

The Maltese collection includes between eighty and ninety species of animal remains, belonging to the classes *Vertebrata, Mollusca, Crustacea,* and *Cirrhipeda, Foraminifera, Echinodermata* and *Zoophyta.* Many of these are in a perfect state, others are casts.

The Vertebrata consist of the remains of Cetacea and of fishes, chiefly sharks. The former have been examined by Professor Owen, and the latter by Sir Philip Egerton. They are considered by those naturalists as tertiary, probably miocene.

A great part of the collection consists of Molluscous remains. Of these, three are Cephalopoda, viz. a Sepia and two species of Nautilus, one of which is the *Nautilus zigzag*, identical with the London clay fossil. One is a Pteropod, the *Vaginula depressa* of Daudin.

Of Pectinibranchous Mollusca, there are numerous species, but mostly in the state of casts. Among the perfect shells of this order are three species of *Scalaria* including the *Scalaria retusa* of Brocchi, a miocene fossil. The casts belong to the genera *Conus, Cypræa, Natica, Oliva Turritella, Turbo, Pleurotoma, Pyrula, Phorus and Trochus.*

Of Branchiopodous Mollusca there are four species belonging to the genus *Terebratula.* Three of these are known species, viz. *Terebratula ampulla* and *bipartita* of Brocchi, fossils of the sub-Apennine beds, and *Terebratula detruncata* of Gmelen (*Orthis* Philippi), a small species still existing in the Mediterranean Sea.

Of Lamellibranchiate Mollusca there are seventeen perfect species and numerous casts belonging to the genera *Thracia, Isocardia, Arca, Venus, Cytherea Lucina,* and *Tellina.* Among the perfect species are three species of oyster, which have been described by Deshayes in the "Geology of the Morea," viz., *Ostrea Boblayei, O. Virleti,* and *O. Navicularis.* Also *Spondylus quinquecostatus, Pecten pandora,* and *P. squamulosus*, figured in the same work. *Pecten cristatus* of the Italian beds, *Pecten burdigalensis, P. scabrellus?* and *P. Beaudanti,* are also present in this collection. The remainder of the species of this genus, which appear to be very characteristic of the Maltese formation, I have been unable to name, from want of materials for comparison. Besides the above-named shells, there are perfect specimens of a *Lucina*, a *Cardita*, and a *Clavagella.*

The remains of Crustacea and Cirrhipoda consist of a few fragments and a good specimen of a *Balanus*, apparently the species figured by Brocchi

under the name of *Lepas stellaris*. Also a species of *Pollicipes* presented by Mr. Greenough.

The *Foraminifera* include the *Lenticulites complanatus* (which appears to be found in those beds in vast numbers), and species of *Nodotes* and *Clarlaris laria*.

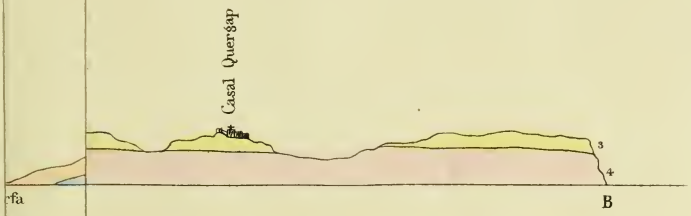
The *Echinodermata* in this collection are numerous, and of remarkable beauty. They include all the Maltese species figured in the work of Scilla, besides several apparently undescribed. They belong to the genera *Cidaris* (one species), *Echinus* (one species), *Nucleolites* (three species), *Galerites* (one species), *Spatangus* (three or four species), *Brissus* (three species), *Clypeaster* (four species), and *Scutella* (one species). Among the last two genera are *Clypeaster altus*, *marginatus*, *Tarbellianus* and *scutellatus*, and *Scutella subrotunda*, several of which are found in miocene beds in the South of France and Italy.

The Zoophyta include species of *Fungia*, *Caryophylla*, *Cellopora*, *Escharina* and *Retepora*. They have been submitted to Mr. Lonsdale, who has recognised among them *Cellepora mamillata*, and *Eschara monilifera*, both French miocene fossils.

As far as can be judged from the examination I have made of them, they belong to a tertiary formation of a later date than the London clay and Paris basin, and older than the Sicilian and other pliocene strata. Certain beds in the South of France and North of Italy, which have been referred to the miocene period, appear to agree in age with the Maltese beds, though they may possibly be older than the Touraine faluns and the English crag.

Note.—A geological map of the island of Malta, made by the Earl of Ducie during a winter's residence in Malta in 1852-3, is about to be published on a reduced scale by Mr. Goodenough, book and mapseller, Strada Reale, Valletta.

BRADBURY AND EVANS, PRINTERS, WHITEFRIARS.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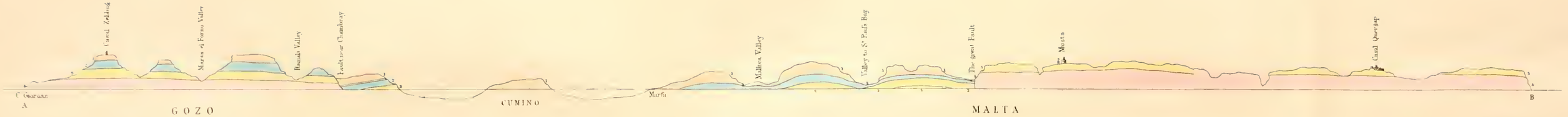
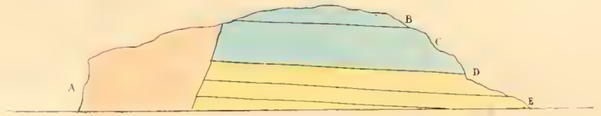
Section 1





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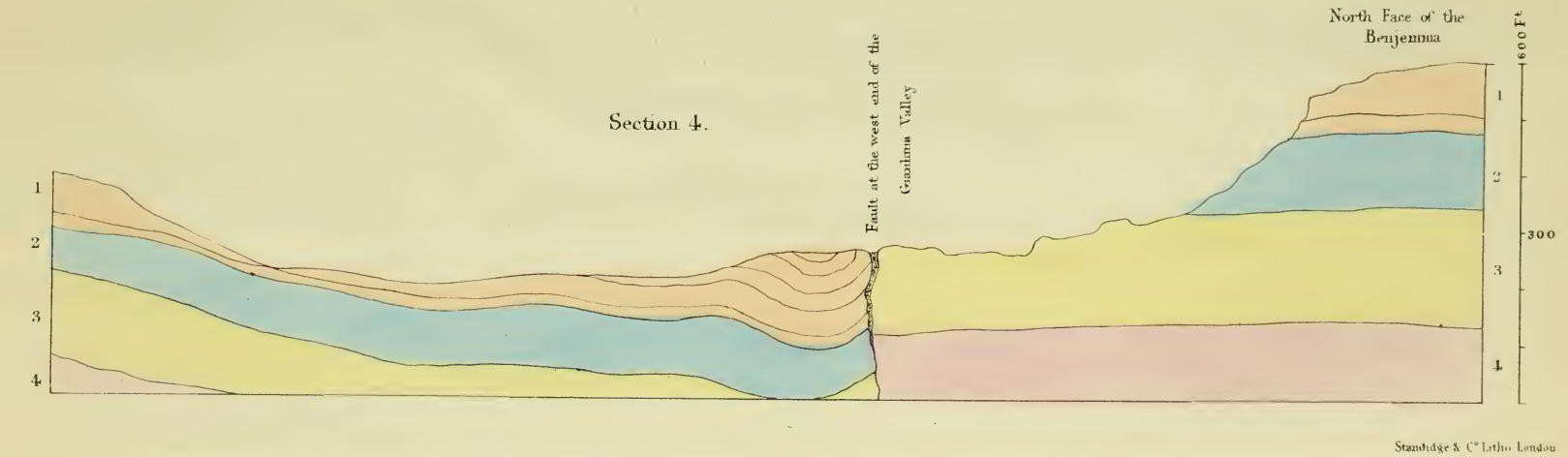

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Section 2.

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Section 3.

Section 4.

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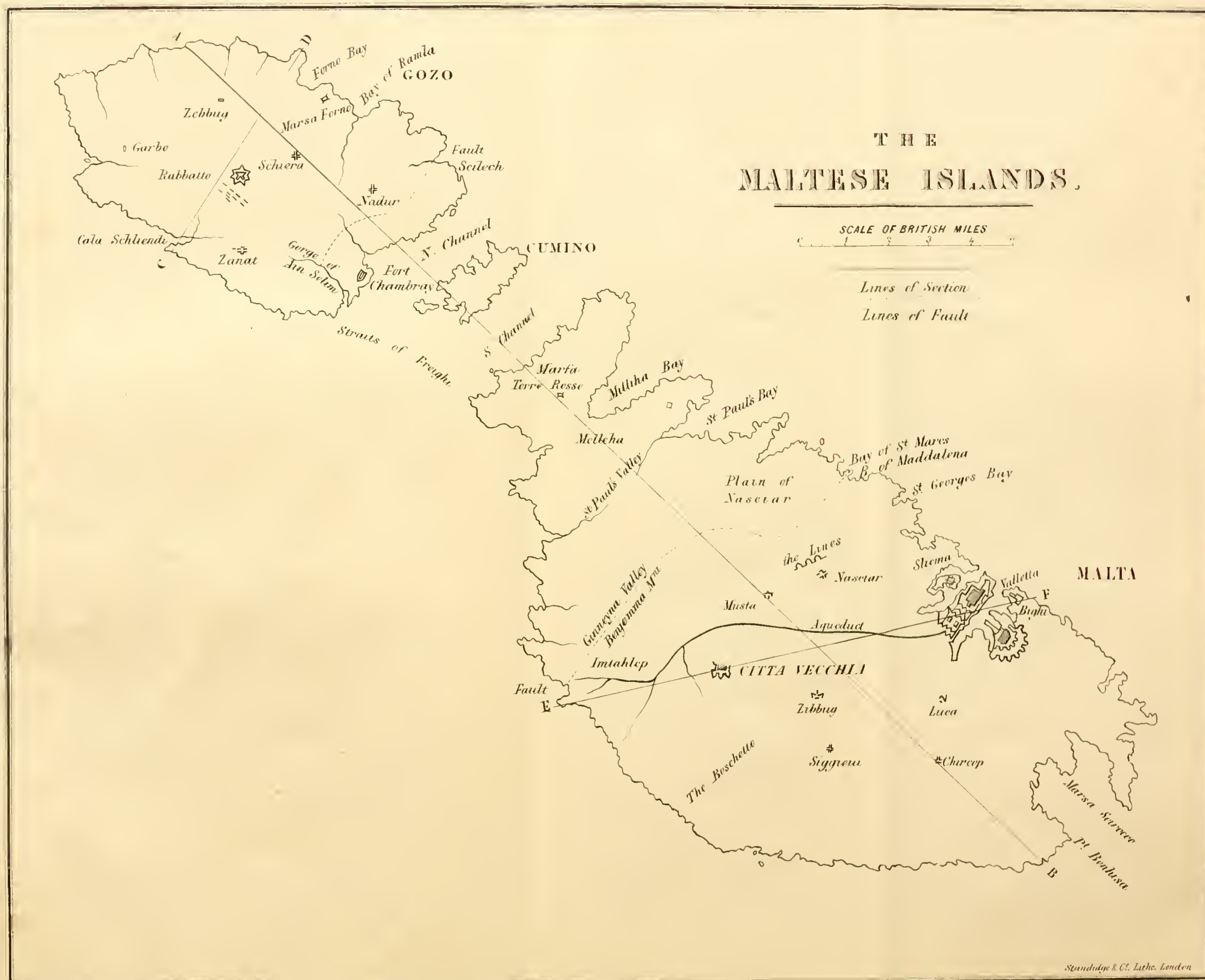

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MALTESE ISLANDS.
SCALE OF BRITISH MILES
Lines of Section
Lines of Fault
GOZO
Forno Bay
Bay of Ramla
Marsa Forno
Zebbug
Garbo
Schiera
Rabbatto
Nadur
Fault
Scilech
Cala Schliendi
Zanat
Gorge of
Ain Selim
Fort
Chambray
N. Channel
CUMINO
Straits of Freghi
S. Channel
Marfa
Torre Resse
Milliha Bay
St Paul's Bay
Melleha
St Paul's Valley
Bay of St Mares
B. of Maddalena
St Georges Bay
Plain of
Nasciar
the Lines
Nasciar
Shiema
Valletta
MALTA
Bighi
Musta
Aqueduct
Ginnejna Valley
Beajemma Mts
Imtahlep
CITTA VECCHIA
Fault
Zibbug
Luca
The Boschetto
Siggeui
Chircop
Marsa Scirocco
Pt Benhusa
A
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C
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